

# PATENT SPECIFICATION



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## PROVISIONAL SPECIFICATION.

### Improvements in or connected with Diaphragms or the like for Sound Reproducers.

I, ALEXANDER ISIDORE ABRAHAMS a citizen of the United States of America, of 18, Washington Place, New York City, United States of America, do hereby declare the nature of this invention to be as follows:—

This invention relates to improvements in or connected with diaphragms or the like for sound reproducers and more particularly though not necessarily exclusively this invention relates to diaphragms for loud speakers of the enclosed moving-coil kind.

When a diaphragm is caused to vibrate such for instance as by being subjected to the influence of sound controlled electric currents passing through a coil connected with said diaphragm and located in a magnetic field, the displacement of the diaphragm will vary in accordance with various factors including factors depending upon the form of diaphragm and the method of mounting such diaphragm. In order to obtain fidelity in the reproduction of sound throughout a wide range of frequencies it is desirable for the diaphragm to move in a piston like manner and for provision to be made for preventing or reducing the tendency for any part of the diaphragm to break into secondary or local vibrations such as give rise to distortion of the reproduced sound and/or undesirable resonance effects. My invention has for its object inter alia to provide a diaphragm which is capable of giving faithful reproduction of sound throughout the audible range of frequencies and which will be of simple and robust construction and of a very sensitive nature.

According to the present invention I provide a diaphragm characterised by the inclusion in said diaphragm of a central and relatively stiff zone, surrounded by an outer and relatively flexible zone which is adapted to be clamped or secured in any convenient manner to a suitable support and an intermediate zone between said inner and outer zones, said intermediate zone having radial flutes or a series of corrugations, depressions, grooves or the like so formed as to stiffen and/or to break up the surface of said intermediate zone in

order to prevent the establishment of secondary nodal points or local vibrations such as may bring in their train distortion and/or undesirable resonance.

It will be readily appreciated that according to my invention the centre part of the diaphragm is adapted to move substantially in a piston like manner, the flexing movements being substantially confined to the outer and more flexible peripheral zone of said diaphragm where the surface however is treated in order to prevent local vibrations.

According to another feature of this invention and in order to enhance the freedom for movement of the aforesaid centre part and in order to define within certain limits the area within which the aforesaid local vibrations are likely to be established, I preferably provide ridges, flutes, corrugations or the like around the part of the diaphragm between the centre zone and the clamped periphery so as to form definite lines about which the unit will tend to flex or bend. Thus for example I may provide two concentrically disposed corrugations around the diaphragm so as to define within the material thereof an annular section to which all flexing movements will be restricted and in such cases this annular section may be treated in the manner before set forth in order to prevent local and undesirable vibrations.

The aforesaid radial flutes or depressions, corrugations or the like may be formed in the material of the diaphragm in any convenient manner and may be of any required shape. Thus for instance flutes of regular channel section may be employed or depressions of circular, elliptical, oval or other suitable shape may be employed or such depressions may be formed by means of two or more intersecting channels for instance arranged in the form of an "X".

A diaphragm unit according to my invention may be made from any suitable material such as a non-magnetic metal or alloy or non-metallic materials may be employed and the aforesaid centre zone is preferably in the form of a cone, part of a sphere or of other suitable curved or substantially conical contour and so

mounted that its apex or convex part is presented towards the mouth or horn of the sound reproducing instrument.

Since in a device according to my invention the centre zone is given great freedom for movement it is apparent that pursuant to the relatively big amplitudes of the movements of this part of the diaphragm there is a tendency for the wire connecting the armature coil to fracture and in order to overcome this tendency I preferably form a loop or coil in this wire at the point where movement takes place.

In order that my invention may be well understood I will now described by way of example one preferred embodiment in greater detail and in application to a moving-coil loud-speaker of the enclosed type.

In this example the diaphragm unit is made of duralumin (Registered Trade Mark) or other suitable material and includes a centre zone of substantially the form of a segment of a hollow sphere, a peripheral zone which is adapted to be clamped to the pot or appropriate parts of the sound emitting instrument and an intermediate zone between the aforesaid two zones. A downwardly projecting flange is formed on the under part of the diaphragm unit and carries the armature or speech coil, this flange may be secured to the centre zone of the unit in any convenient way or it may be integral therewith, thus said flange may be formed by an extension of part of the shell of the aforesaid inner zone.

The aforesaid inner zone is by reason of its gauge and shape relatively rigid but the peripheral part is relatively flexible, it is thus apparent that any bending movements of the diaphragm are limited to the aforesaid intermediate zone and such movements may give rise to local vibrations or the like. In order to break up the uniformity of the surface and prevent undesirable resonance or the like I form a series of radial flutes in this zone, said flutes being for instance formed in a

stamping or pressing operation and in order effectively to restrict all bending movements to this so treated zone I preferably provide two grooves, channels or the like around the boundaries of said zone. These channels or the like in the example being described will of course be in the form of two concentric circles and may be formed during the stamping or pressing operation employed for the purpose of forming the channels, flutes or the like in the aforesaid intermediate zone of the diaphragm or as a separate operation. If desired holes, slots or the like may also be formed in the peripheral zone of the diaphragm for receiving the clamping bolts or studs during the aforesaid pressing or stamping process.

In the example under consideration the armature or speech coil is wound on the circular flange projecting below the main body of the diaphragm and the wire of said winding is looped or coiled at the point of lead off from the moving part of the diaphragm to the clamped part so that the desired play is afforded to obviate fracture of said winding by reason of movements of the diaphragm.

Whilst I have hereinbefore given an example of a diaphragm according to my invention I wish it to be understood that the particular details and arrangement of parts may be varied or modified without departing from the scope thereof. Thus for instance the unit may be made from any suitable material or materials and may be of any desired dimensions, further whilst I have described a diaphragm according to my invention in application to a moving coil loud speaker of the enclosed type it is to be understood that my invention may be applied to other types of loud speakers or sound reproducers.

Dated this 2nd day of December, 1931.

For the Applicant,

FRANK B. DEHN & Co.,

Chartered Patent Agents,

Kingsway House, 103, Kingsway, W.C. 2.

## COMPLETE SPECIFICATION.

### Improvements in or connected with Diaphragms or the like for Sound Reproducers.

I, ALEXANDER ISIDORE ABRAHAMS a citizen of the United States of America, of 18, Washington Place, New York City, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to improvements in or connected with diaphragms or the like for acoustic devices and more particularly though not necessarily exclusively this invention relates to diaphragms for loud speakers of the moving-coil kind.

When a diaphragm is caused to vibrate such for instance as by being subjected to

the influence of sound controlled electric currents passing through a coil connected with said diaphragm and located in a magnetic field, the displacement of the diaphragm will vary in accordance with various factors including factors depending upon the form of diaphragm and the method of mounting such diaphragm. In order to obtain fidelity in the reproduction of sound throughout a wide range of frequencies it is desirable for the diaphragm to move in a piston-like manner and for provision to be made for preventing or reducing the tendency for any part of the diaphragm to break into secondary or local vibrations such as give rise to distortion of the reproduced sound and/or undesirable resonance effects. My invention has for its object, inter alia, to provide a diaphragm which is capable of giving faithful reproduction of sound throughout the audible range of frequencies and which will be of simple and robust construction and of a very sensitive nature.

According to the present invention I provide a diaphragm including a central part or zone adapted to vibrate in a piston-like manner, an outer part or zone which is adapted to be clamped or otherwise secured to a suitable support, and an intermediate zone between said clamped edge and central zone, said intermediate zone being stiffened in a radial direction at a series of spaced points and having one or more annular corrugations, ridges or the like defining its inner and/or outer limits, said corrugation or corrugations or the like being spaced from said stiffened points.

The aforesaid intermediate zone may be stiffened for instance by means of a plurality of bosses, corrugations depressions, grooves, flutes or the like spaced from each other and from the annular corrugation, corrugations or the like.

The aforesaid flutes, bosses or the like formed in the intermediate zone of the diaphragm break up the surface of that zone and tend to prevent any local vibrations or establishment of secondary nodal points which may bring in their train distortion and/or undesirable resonance and the annular corrugation, corrugations or the like form clearly defined lines or zones about which flexing of the diaphragm may readily take place as the centre zone is caused to move in a piston-like manner.

I preferably provide one annular corrugation around the edge of the central stiffened zone and a second annular corrugation substantially in alignment with the inner edge of the clamped part of the periphery of the diaphragm. All flexing of the diaphragm will then be substan-

tially confined to the zone between said annular corrugations and by stiffening such zone in the above mentioned manner at points spaced from said annular corrugations the flexing movements are substantially limited to bending movements about these corrugations and local vibrations of the material are avoided.

The aforesaid depressions, channels, flutes, bosses or the like for stiffening desired parts of the outer zone of a diaphragm according to this invention may be formed in any convenient manner and be disposed radially or in any other suitable arrangement. Such depressions flutes, bosses, or the like may also be of any desired shape. Thus for instance I may provide flutes of regular channel section or of a section adapted to give uniform stiffening properties throughout their length or depressions or the like of circular, elliptical or oval shape may be employed. In yet another arrangement such depressions or the like may be formed by two or more intersecting channels, thus they may be in the form of a series of pairs of channels arranged in "X" formation.

A diaphragm unit according to this invention may be made from any suitable material such for example as a non-magnetic metal or alloy or from suitable non-metallic material and the centre zone may be stiffened in any convenient manner. Thus it may be domed and be substantially of conical shape or in the form of a section of a sphere or other curved body. In cases wherein said central zone is in the form of a dome, the diaphragm is preferably so mounted that its apex or convex part is presented towards the orifice of the acoustic device and such device may be either of the hornless kind or of the kind employing a horn and may include an electro-dynamic driving unit of the moving coil kind or any other suitable driving unit may be employed.

Since in a device according to this invention the centre zone is given great freedom for piston-like movement the amplitude of such movement will be relatively big and will cause material flexing of the wires leading from the speech coil when such a mode of driving the unit is employed. This flexing of the wires may tend to fracture them and in order to oppose this I preferably form one or more loops in said wires at the part or parts where maximum movement occurs so that material bending of the wire is avoided.

In order that my invention may be well understood I will now describe by way of example one embodiment thereof with reference to the accompanying drawing which shows one form of diaphragm in

rear elevation.

Referring to the figure, the diaphragm comprises a central dome-shaped portion 7 and an annular portion or flange including a peripheral portion 10 and an intermediate annular zone 8. The zone 8 includes a plurality of depressions, flutes or the like 9 spaced from each other and arranged radially. In the drawings the aforesaid depressions are shown substantially of oval shape with their narrow ends presented towards the central zone 7. It is obvious, however, that the number, shape and arrangement of such depressions or the like may be varied in many ways, their function being to stiffen the zone in a radial direction at a plurality of spaced points. The peripheral part 10 of the diaphragm is adapted to be clamped to the acoustic device in any convenient manner, said clamped section as well as the periphery of the domed centre zone of the diaphragm being spaced from the depressions 9 so as to form two circumferential bending zones. An annular corrugation, depression or the like 11 is provided in the outer bending zone and another annular corrugation, depression or the like 12 is provided in the inner bending zone in order to confine substantially all bending movements to said annular corrugations or the like and to provide great freedom for the piston-like movements of the central zone 7.

The aforesaid diaphragm is in this example stamped from a single sheet of metal, for instance, of aluminium or a suitable aluminium alloy, such as Duralumin (Registered Trade Mark) and the thickness is about .002 of an inch.

When the part 7 is caused to vibrate it will move in a piston-like manner owing to the stiffening of that part due to its domed shape, and owing to the stiffening of the part 8 bending movements will be limited to the annular corrugations in the zones between the depressions 9 and the clamped edge 10 and periphery of the zone 7 respectively. In view of the fact that the maximum bending movements tend to take place in the zone between the edge of the dome 7 and the depressions 9, the clamping member employed for securing the diaphragm in position may be of a width equal to the width of the flange 10 so as to confine substantially all bending movements to the corrugation in the above mentioned inner zone although, the inner edge of said clamping ring is preferably spaced from the ends of the depression 9 so as to provide for two circumferential bending zones.

In the example shown in the figure an annular flange projects from the end of the central zone 7, and serves as a carrier for

a speech coil, the ends of which are designated 13 and 14. This flange may be secured to the diaphragm in any convenient way or it may be formed integrally therewith, thus for instance, it may be formed by a skirt portion of the dome 7 projecting beyond the plane of the annular part of the diaphragm. In view of the considerable bending movements which may result from constructing a diaphragm in a manner according to the present invention it may be found that there is a tendency for the wire of the speech coil to fracture if it is caused to bend in unison with the diaphragm. In order to prevent this I preferably provide loops 15, 16 in the parts of the wires adjacent to the corrugation 12 and if desired similar loops may be provided adjacent to the corrugation 11.

Although in the above example I have shown the centre part of the diaphragm in the form of part of a sphere I wish it to be understood that such part may be of many other suitable shapes, the essential requirement being that this part be sufficiently stiff to be capable of moving in a piston-like manner and that the peripheral part be sufficiently flexible to permit of this movement.

Whilst I have hereinbefore given one example of a diaphragm according to this invention I wish it to be understood that the specific details may be varied or modified without departing from the scope thereof. Thus, for instance the diaphragm may be made from any suitable material and of any desired dimensions and may be used in various forms of sound recording or reproducing instruments and any suitable means may be employed for stiffening the centre part of the diaphragm and for stiffening the desired parts of the flexible zone thereof. Moreover, whilst in some cases a diaphragm according to this invention can be formed by a single stamping operation or any other suitable method of making such diaphragm may be employed.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A diaphragm for acoustic devices having a central part or zone adapted to vibrate in a piston-like manner, an outer part or zone adapted to be clamped or otherwise secured to a suitable support, and an intermediate zone between said clamped edge and central zone, said intermediate zone being stiffened in a radial direction at a series of spaced points and having an annular corrugation or the like defining its inner and/or outer limits, said

annular corrugation or corrugations being spaced from said stiffened points.

2. A diaphragm as claimed in claim 1 in which said intermediate zone is stiffened by means of a plurality of spaced bosses, depressions, corrugations or the like formed in the material forming said diaphragm.

3. A device as claimed in either of claims 1 and 2 in which the inner ends of the stiffened parts of the intermediate zone are spaced from the periphery of the central part or zone of the diaphragm so as to form an annular zone in which bending movements may readily take place.

4. A device as claimed in any of the preceding claims in which the outer ends of the stiffened parts of the intermediate zone are spaced from the clamped periphery of the diaphragm so as to form an annular zone in which bending movements may readily take place.

5. A device as claimed in any of the preceding claims, in which the intermediate zone is stiffened by means of a plurality of spaced bosses, depressions or the like disposed substantially radially in an annular zone.

6. A device as claimed in claim 5 in which the bosses, depressions or the like have substantially uniform stiffening qualities throughout their radial length.

7. A device as claimed in any of the preceding claims in which the bosses, depressions or the like are substantially of tapered form, the narrow ends of said bosses, depressions or the like being directed towards the central zone of the diaphragm.

8. A device as claimed in any of the preceding claims in which the desired stiffness is imparted to the central zone of the diaphragm by suitably deforming such part from a plane condition.

9. A device as claimed in any of the preceding claims in which the central zone of the diaphragm is of dome shape, for instance in the form of a part of a sphere.

10. A device as claimed in any of the preceding claims characterised in that it is formed from thin sheet metal, for instance aluminium or Duralumin (Registered Trade Mark).

11. A device as claimed in any of the preceding claims in which the diaphragm is formed by means of a single stamping or pressing operation.

12. A device as claimed in any of the preceding claims in which a flange or the like for carrying a speech coil is secured to or formed integrally with part of the diaphragm.

13. A device as claimed in any of the preceding claims in which a speech coil is mounted thereon and the ends of said speech coil are looped at or adjacent to the part or parts of the diaphragm to which bending movements are substantially confined.

14. A diaphragm for acoustic devices substantially as hereinbefore described or as shown in the accompanying drawings.

Dated this 2nd day of December, 1932.

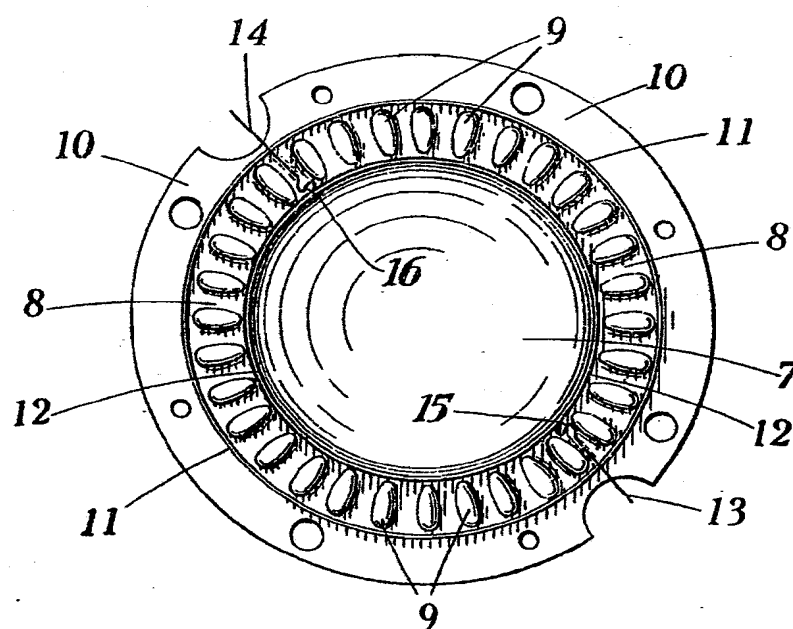
For the Applicant.

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Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1933.

[This Drawing is a full-size reproduction of the Original.]



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